Throwin' Shade: Furthering the Analysis of Residential Solar Access in Massachusetts

Abstract

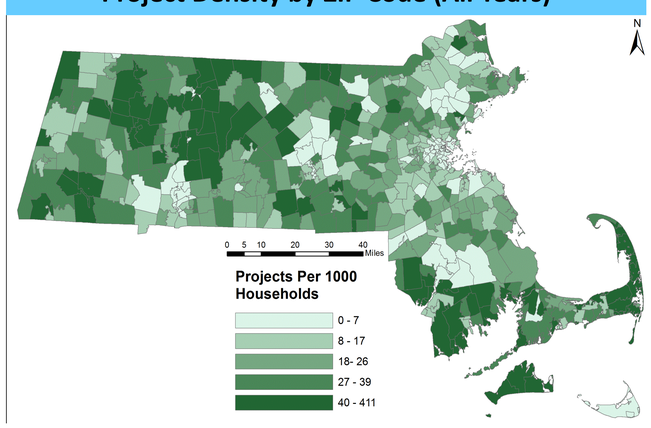
As distributed solar has burgeoned in Massachusetts, community organizations and researchers have noted that high upfront cost, home ownership requirements, transiency, and other factors are funneling residential solar projects away from low- and moderate-income communities and Communities of Color. Incentives for solar were drastically reduced in 2016 with the expiration of the Solar Renewable Energy Credit program and the legislature's reduction of net metering benefits. Small (<10 kilowatt) residential projects have received some exemptions from these changes, whereas community shared solar programs have lost out on direct support – the fear is that concentration of solar projects in wealthier communities will continue under the new paradigm. The purpose of this project is to supplement previous analyses that examine whether disparate access to residential solar in Massachusetts is, and will continue to be, an equity concern.

Methods and Data

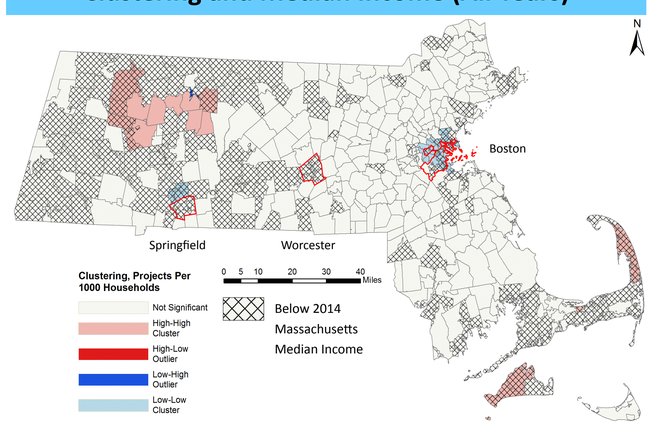
The primary methods employed in this study are (1) a cluster analysis of solar project density using local Moran's I and (2) visual overlay of demographic variables on cluster and density data to analyze spatial overlap. The unit of analysis is ZIP code, and density is defined as the number of installations per 1000 households. Demographic variables of interest include median income, percentage of households with a nonwhite head of household, and percentage of households that rent. Summary statistics for these and other variables are presented in the data table. Throughout the analysis, "all years" signifies the years 2000-2016.

Demographic data come from the 2014 American Community Survey five-year averages. Data on residential solar installations and costs come from the Massachusetts Clean Energy Center (Mass CEC) Production Tracking System, which tracks all solar projects since 2000 that qualified for participation in the Massachusetts Solar Renewable Energy Credit Program. I define "residential" solar projects as those on residential structures with three or fewer units, residential structures with four or more units, or mixed residential and commercial structures. The first category represents 99.8% of projects across all years.

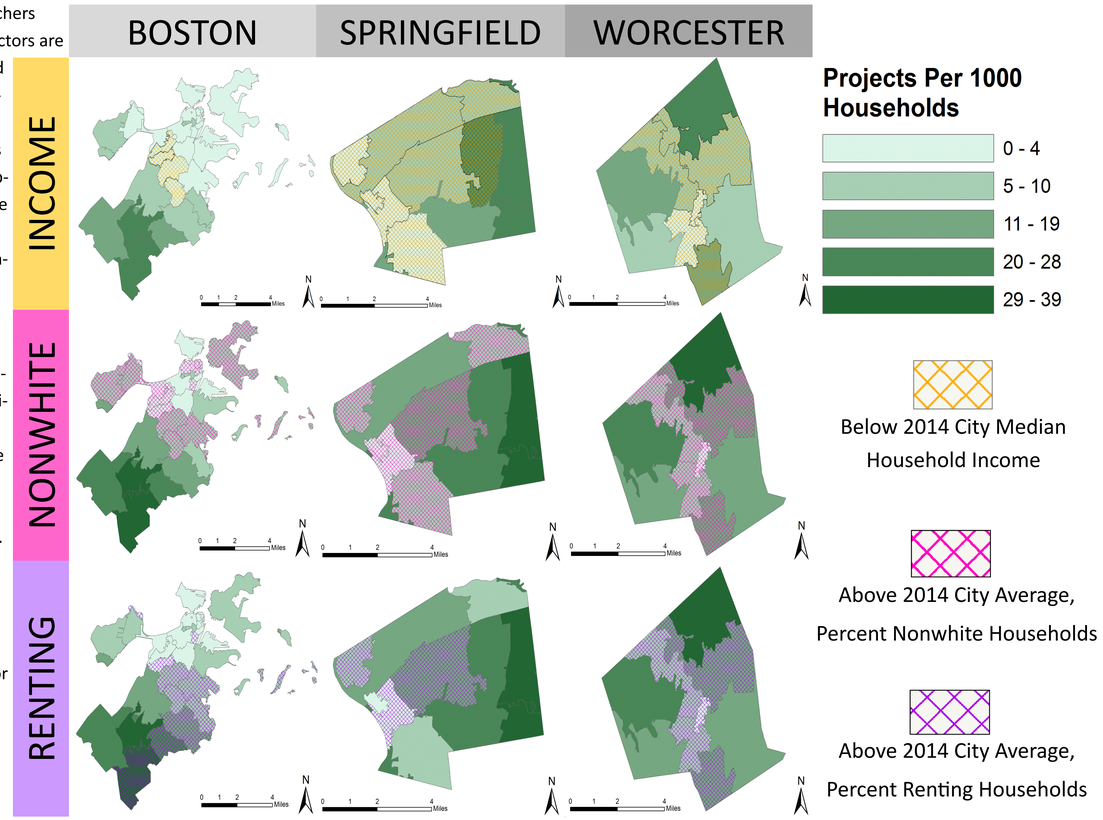
Project Density by ZIP Code (All Years)



Clustering and Median Income (All Years)



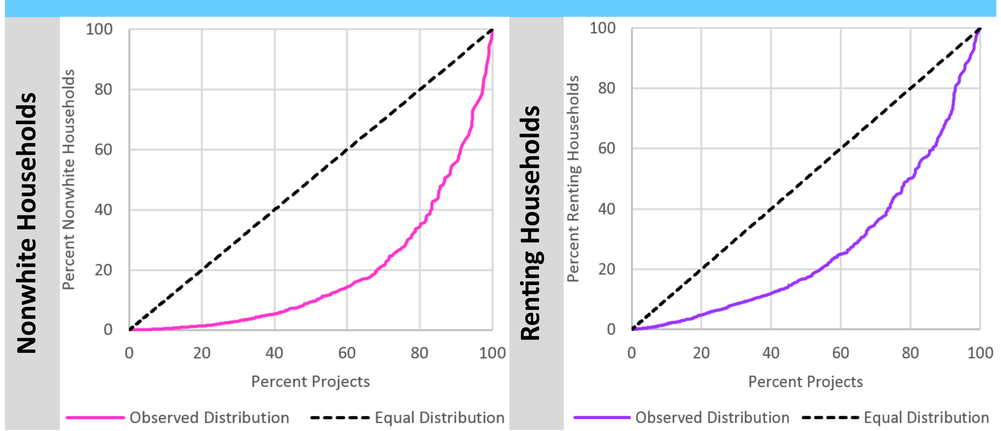
Project Density and Demographics by City (All Years)



Summary Data

Jurisdiction	Projects, All Years	Projects, 2014-2016	Avg. Cost per kW (All Yrs., $2016)	2014 Median Income ($2016)	2014 Nonwhite Households	2014 Renting Households
Massachusetts	46,521	36,512	$ 5,067.04	$ 69,202.92	16.31%	37.72%
Boston	1,552	1,060	$ 5,261.73	$ 35,425.62	41.13%	65.84%
Springfield	532	491	$ 4,825.12	$ 55,574.70	41.50%	52.16%
Worcester	769	687	$ 4,951.36	$ 47,027.10	23.74%	55.98%

Distribution of Projects vs. Demographics by ZIP Code (Statewide, All Years)



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Projection (all maps): Lambert conformal conic
Coordinate System (all maps): NAD 1983 MA Mainland State Plane
Data Sources: Tufts GIS Server (for state, town, and ZIP code boundaries), American Community Survey (www.census.gov), Massachusetts Clean Energy Center (www.masscec.com)

Results

The first map on the far left presents the density of residential solar projects in Massachusetts ZIP codes by quintile across all years. Pockets of high and low density are clearly visible throughout the state. The second map presents clustering of project density against ZIP codes whose median income was below the 2014 state median. Significant clustering of high project density is evident in the northern Pioneer Valley and on the Cape and Islands, whereas significant clustering of low project density is evident north of Springfield and in Greater Boston; this is very similar to the findings of previous studies. As indicated in the summary data table, a large portion of all projects were undertaken since 2014, which is the year of the most recent statewide analysis. A clustering analysis (omitted) of projects undertaken from 2014 to 2016 produced similar results, which suggests that clustering patterns have continued over time. Whereas the low density clusters in the Springfield and Boston areas generally overlap with ZIP codes that have a low median income, there is also overlap between this category of ZIP codes and the high clusters. Overlays of race and renting data on clustering produced similar results and were therefore omitted. Given this relative inconclusiveness, I opted to take a closer look at outcomes within the state's three most populous cities: Boston, Springfield, and Worcester.

The primary set of maps at the top presents project density in the three cities by quintile (specific to these cities) overlaid with local income, race, and renting data. Whereas a handful of ZIP codes that fall into the demographic categories of interest do have somewhat high project density, it is worth noting that the first two quintiles correspond to at most 10 projects per 1,000 households, or a 1% uptake. Furthermore, the demographic categories always overlap with some or all of the ZIP codes in the lowest quintile of project density. This overlap is most stark with regard to median income and nonwhite households in all three cities, and particularly in Boston. Of course, there is a high degree of overlap between low median income, high percentage of nonwhite households, and high percentage of renters in the three cities generally, and this overlap is nearly exact in Worcester.

Notwithstanding the caveats noted below, this analysis suggests the continued concentration of residential solar projects in wealthier, whiter communities with lower renting incidence. The charts at the bottom center of this poster provide further evidence of the unequal distribution of residential solar statewide. For example, ZIP codes that contain 50% of projects are home to only about 10% of the state's nonwhite households and 17% of the state's renting households. In either case, an equal distribution would follow the forty-five degree dotted line.

Sources of Error

The primary source of error in this analysis is that Massachusetts CEC data are only available by ZIP code. Thus, it is impossible to know the income, racial identity, or renter status of a household that undertook any particular solar project. Furthermore, incentives such as tax breaks, grants, and net metering benefits were not included (for example, do low- and moderate-income households receive more grant money overall?), though these data would also suffer from lack of specificity at the ZIP code level. Finally, I did not compare outcomes with local rooftop suitability, though this restraint neither diminishes nor excuses the existence of a disparity in access. Given the substantial average costs per kilowatt listed in the summary table, the significant barriers to uptake by low- and moderate-income households noted by previous researchers, and the recent cuts to state incentives, there is a low probability that trends at the household level run counter to this analysis.

Conclusion

This study provides additional evidence that residential solar projects in Massachusetts have tended towards communities that are wealthier, whiter, and have higher levels of homeownership. The trend appears to have continued in the two or three years since the most recent statewide studies were conducted. Given that exemptions to recent changes in solar incentives are largely directed towards small residential solar projects, the immediate policy implication is that the differential access to distributed solar experienced by low-and moderate-income communities and Communities of Color in Massachusetts will be exacerbated in the coming years. This is an inequitable outcome; it does not reflect a balanced transition to a clean energy future, but rather a transition in which benefits largely accrue to higher income brackets. The state government must come to terms with this reality if it seeks to promote social justice while furthering the "green revolution" and achieving its climate goals. To the extent that household-level research regarding solar access is possible, this would provide critical insight into the true scope of differences, as well as into any local roadblocks that could be addressed on a local scale. The state must also revise its incentive structure to ensure future support for low- and moderate-income communities, and in particular for models such as community shared solar that need not require rooftop access or long-term residency.